A Guide to Aquatic Nuisances and Their Control

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Saskatchewan Environment
Environmental Protection Branch

Foreward

This is a general information guide on the control of aquatic nuisances with emphasis on "prevention" of the problem. The reader is encouraged to check the internet and other information sources for information specific to their nuisance and to keep abreast of the various regulatory requirements and the latest advancements in "environmentally friendly" control measures. The department would appreciate your comments and or additional knowledge you may have regarding this guide and aquatic nuisance control measures. Please address them to:

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1. Introduction

The purpose of this guide is to provide information on:

- aquatic ecosystems;
- identification of aquatic plants and animals;
- effective and responsible control of aquatic nuisances; and
- regulations governing aquatic nuisance control programs in Saskatchewan.

Additional references and contacts are also included in this guide to assist the reader in obtaining more detailed information. This guide places particular emphasis on being environmentally conscious in planning a nuisance control program. Prevention and understanding of the ecosystem imbalance rather than on chemical treatments will be emphasized.

1.1 Aquatic Ecosystems

All freshwater systems naturally evolve from relatively barren infertile (oligotrophic) waters to productive (eutrophic) systems supporting a wide diversity of organisms. Human development around surface waters accelerates the evolution toward the mature productive stage and when unchecked, can lead to an unhealthy, over productive (hypereutrophic) level.

Most aquatic plants that are considered nuisances are a result of excess nutrients and occur in and around surface waters within two biologic zone:

- the riparian or shoreline zone acts as a filter, removing nutrients from runoff prior to it entering the water body. Plants in this zone slow runoff thereby allowing water to soak in and replenish groundwater and they reduce erosion by anchoring soil in place; and
- the littoral zone is the shallow water around the shore of lakes in which there is rooted vegetation. This zone also removes nutrients entering the system from runoff and the density of the growth can sometimes be used as an indicator of the amount of nutrients present. The use of aquatic vegetation (macrophytes) to filter water has been recognized and is being engineered into sewage and industrial treatment systems. The littoral zone is also the main habitat for tiny animals (zooplankton) and minnows, which in turn are the food source for game fish such as pike and walleye.

Certain aquatic plants and animals can be called "aquatic nuisances" when they become present in sufficient numbers to pose problems for people or animals using a water body or its surrounding environment. Aquatic ecosystems represent a delicate balance of many factors and the proliferation of certain aquatic plants and animals occur when the system becomes imbalanced. This can occur naturally (e.g. mosquito outbreaks can result from wet or rainy weather), or be induced by man (e.g. excessive plant growth due to nutrients or pollutants from septic systems, agricultural fertilizers, urban runoff, industrial byproducts, etc.). Population outbreaks of certain aquatic plants and animals are generally an attempt by the aquatic ecosystem to restore its natural balance (e.g. excessive plant growth to use up excessive nutrients). If the element that is causing the upset is reduced, the system will return to a state of balance. However, if the factor(s) that is causing the upset is not reduced or stopped the system cannot return to its balanced state.

The most effective means of aquatic nuisance control is to prevent the aquatic ecosystem from becoming out of balance. If the aquatic ecosystem is already out of balance, the next most effective measure is to eradicate the element or factor that is causing the system to be out of balance. There may be a delay in

seeing the results of reducing a nutrient, as the system will take a while to use up accumulated amounts of the element out of balance. If neither of the above is possible then the next alternative, aside from learning to live with the nuisance, is to reduce the specific nuisance. This measure will merely be treating the symptom, not the cause of the problem. Measures to control one type of aquatic plant or animal can have undesired effects on other aquatic or terrestrial species. It is very important that effective and environmentally responsible control of aquatic nuisances is done. This is only achievable once one acquires knowledge of the chemical alternatives, their pros and cons, the aquatic ecosystem and the types of aquatic plants and animals that may need to be considered at a particular site.

2. Preventing Aquatic Nuisance Problems

The most effective means of aquatic nuisance control is to prevent the problem(s) from occurring in the first place. As the old adage goes " an ounce of prevention is worth a pound of cure". This requires good foresight and familiarity with aquatic ecosystems and how they function (see referenced books for more information). A thorough understanding of the aquatic system to be treated is necessary. Some of the questions that should be considered are:

- what is the nature of the water body and its watershed and what are the nutrient inputs;
- are preventative measures such as reducing nutrient loadings from fertilizers, sewage, soil erosion, urban runoff, livestock operations or pollutants from industry being implemented; and
- is there a buffer zone of natural vegetation between the water body and developments?

Cottage owners:

- ensure septic systems are functioning properly;
- do not wash vehicles, boats, dishes, dogs, hair etc. in your lake;
- reduce or stop the use of fertilizers and pesticides on lawns;
- remove leaves, grass clippings and weeds away from lake shorelines, leaving them to rot will return nutrients to the lake;
- slow boat motors in shallow water. Disturbance of nutrients in bottom sediments fertilize water above them; and
- practice good lake management measures and keep abreast of the most current information available.

For manmade water bodies such as dugouts, ponds, lakes and reservoirs, consider the design and its effect on the formation of aquatic nuisance problems:

- will the water body be deep (preventing rooted aquatic weed growth) or shallow (promoting rooted aquatic weed growth);
- are the banks steep (preventing aquatic weed growth) or do they have very little slope (promoting aquatic weed growth);
- are there trees, grass, sand or rocks along its shores (a natural buffer zone);
- is the bottom sand, gravel or cobble, or is it lined thereby inhibiting aquatic weed growth;
- what is the source of water or the nature of its watershed; and
- what kind of human or animal activity exists or will exist, in the water body and or watershed?

Knowing the above information before the water body is created will help predict or lessen potential aquatic nuisance problems from occurring in that water body.

To prevent infestations of aquatic nuisances that are not native to Saskatchewan (sometimes referred to as "exotic pests"), such as Eurasian Water Milfoil, Zebra Mussels, Purple Loosestrife etc., make sure you check your car, boat etc. thoroughly to insure that you are not transporting one of these foreign species into Saskatchewan.

3. Planning an Effective Nuisance Control Program

If preventative measures have not been implemented and an aquatic nuisance problem already exists one must develop a plan to deal with the problem. Planning an effective aquatic nuisance control program can be a complicated affair. It requires an understanding of aquatic ecosystems and the plants and animals that inhabit them (see reference section).

The first step in planning an effective nuisance control program is to identify what the problem is by identifying the nuisance aquatic plant or organism and its characteristics. Next, determine the severity of the problem:

- is it a threat to human or animal health;
- how serious or costly is the problem;
- is it absolutely necessary that the nuisance be controlled;
- can it be left untreated (i.e. can you learn to live with it); and
- is it a short-term, long-term or a reoccurring problem?

If it is deemed absolutely necessary that the problem be treated, then determine:

- what caused this particular aquatic plant or organism to become a nuisance; was it caused by nature or induced by man? Is it a result of a lack of or imbalance in competing predators or organisms; and
- can the condition(s), which caused the problem, be stopped or controlled?

For example, if aquatic plants have become a nuisance, can the nutrient loadings to the waterbody be controlled (i.e. leaks in septic systems fixed, livestock watered away from the waterbody etc.)?
If the cause of the problem cannot be controlled then the next step is to try and control the aquatic nuisance itself. In the past this is what most of the control measures have focused on. However, controlling one particular aquatic plant or animal merely treats the symptom of the problem and may have undesired effects on other aquatic or terrestrial life. Therefore, this is usually not the best approach because the problem will probably keep reoccurring and may need continuous treatments, but in many cases it may be the only option.

If this is the case then there are many control measures that may be tried for a particular aquatic nuisance. When making the best possible choice on which control measure to use one should consider the following:

- knowledge of the particular nuisance to determine for example, the best possible timing of treatment (see Section 4);
- knowledge of the various control methods available and the costs and benefits of each (see Section 4);
- regulations governing the various control measures (see Section 5); what, where and when can be used and what, where and when cannot be used;
- the side effects, health hazards, environmental impacts;

- any safety precautions;
- effectiveness in controlling the problem and suitability for the individual circumstances; and
- duration of action: need for multiple treatments.

4. Information on Types of Aquatic Plants and Animals that can become Nuisances in Saskatchewan and Measures to Control Them

4.1 Aquatic Plants

Aquatic plants can be described as emergent, submergent or floating. The following three sections will describe each type, the plants involved, some of the benefits they provide and the problems they create. For a more detailed identification and description of these plants refer to the reference section in the back of this guide.

4.1.1 Emergent Aquatic Plants

Figure 1: Arrowhead
(Sagittaria cuneata)

Named from its leaves, which usually are shaped like arrowheads. Submerged leaves may be narrowly linear. This plant grows in marshes and shallow areas or shores of lakes. The roots bear tubers, and the waxy white flowers occur in groups of 3. Height 20-40 cm (8-16 inches).

(Refs. Fassett 1957, Moss 1959).

Figure 2: Bulrushes
(Scirpus sp.)

The stems are green, cylindrical and may grow 2 cm (3/4 inch) in diameter and 2 1/2 metres (8 feet) tall in some species. Flowers may appear to grow from the side of the stem. The hard stem bulrush can grow in water up to 2 metres (6 feet) in depth. Other types are found in more shallow areas. Bulrushes are used for food by wildlife and are important as soil binders.

(Ref. Caldwell 1962).

Figure 3: Cattail
(Typha latifolia)

Cattails grow in thick patches from creeping root-stocks and often attain heights of 2 1/2 metres (8 feet). They can grow on wet ground and in shallow water. The flowers form a dense, dark brown, cigar-like spike. Cattails provide excellent habitat for birds and small mammals.

(Ref. Fassett 1957).

Figure 4: Marsh Smartweed
(Polygonum coccineum)

This plant has dark green, shiny leaves, which may either float on the surface or protrude above the water. The pink or white flowers grow in an erect spike above the water. The plant occurs both in shallow water and on wet land. Height 30-100 cm (12-40 inches).

(Refs. Caldwell 1962, Moss 1959).

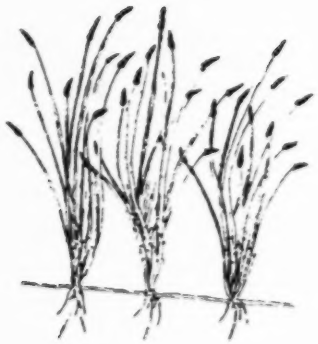


Figure 5: Rushes
(Juncus effusus)

Found in moist areas such as the edges of lakes, ponds and marshes, rushes have round stems that can be hollow, pithy or partitioned. The leaves may be hollow, spear like or flat. The green or brown flowers are borne on the end of the stem, but in some species, they may appear to grow from the side of the stem. Height 20-80 cm (8-32 inches).

(Refs. Fassett 1957, Moss

1959)

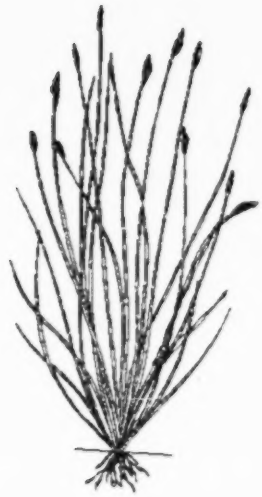


Figure 6: Spikerush
(Eleocharis sp.)

These plants occur along the edges of sloughs and ponds both in shallow water and on wet ground. The stems are green and leafless and end in a single spike. Height 10-100 cm (4-40 inches).

(Refs. Fassett 1957, Moss 1959)

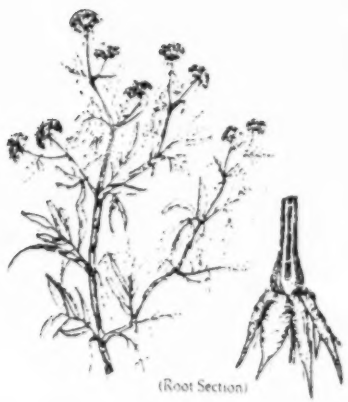


Figure 7: Water Hemlock
(*Cicuta maculata*)

This plant grows in the shallows or on wet shores beside still or running water. The stems are hollow and usually erect. The long, narrow leaves are in groups of three. Small flowers are located at the tip of the stem on radiating stalks of equal length. Height 30-180 cm (1-6 feet). **It is extremely poisonous.**

(Refs. Fassett 1957, Cook 1974, Moss 1959)

Figure 8: Whitetop
(*Fluminea festucacea*)

This plant is a perennial grass associated with wet areas. It is topped with a whitish, feathery-branched flower cluster containing oat-shaped seeds. Height 1-1.5 metres (3-5 feet).

(Refs. Caldwell 1962, Fassett 1957)

Figure 9: Purple Loosestrife
(Lythrum saliciaria)

This plant has become a serious weed pest in several regions of Canada and United States. It is an emergent plant that grows very well in marshes, wetlands, stream banks, canals etc. It is a perennial flowering plant that can grow up to 1.5 meters tall and it is distinguished by the beautiful purple-pink flowers that form 10 to 40 centimeter long spikes. A single plant can produce up to 30 or more stems giving it a bushy appearance. Its affect on native wetlands and wildlife was not apparent until recently as conditions over the past several years have made its presence and impact more visible. The beautiful flower masks a very aggressive and highly competitive species as it displaces all other native vegetation. Purple Loosestrife is capable of out competing all native wetland plants, through a combination of basic hardiness, prolific seed production (2.5 million seeds per year), vegetative reproduction and sprouting. It quickly shades out native species, is impalatable and impenetrable to most wildlife and it builds up the soil around its center thus gradually rendering the wetland shallower and eventually dry. It does have some benefits aside from its natural beauty; its flower can be used as a red colouring extract for candy and pastry and it has also been reported to have some medicinal properties. In Saskatchewan it remains quite stable, however, the potential for nuisance outbreaks exists. For this reason, aquatic nuisance control managers should be aware of it and can help by actually removing any small clumps of purple loosestrife found and properly disposing of it. Also, report the location of the plant to the Saskatchewan Purple Loosestrife Project at their toll free hotline number 1-800-281-3006.

4.1.2 Submergent Aquatic Plants

Most submergent plants are anchored in one place with roots and have no foliage extending above the water surface. Submergent plants are useful in providing shelter for fish and can also help oxygenate the water. They serve as food for waterfowl, muskrats and moose. In excess, they may restrict carrying capacity in irrigation canals, choke pump inlets or reduce the recreational quality of lakes and streams.

The following are typical submergent water plants in Saskatchewan.

Figure 10: Bladderwort
(Utricularia vulgaris)

Bladderworts are rootless plants that float just below the surface of ponds, lakes and streams. The thread-like leaves bear small, brown bladders (3-5 mm long) which act as a trap for small animal life. Flowers are yellow and extend above the water surface on long stalks.

(Ref. Caldwell 1962)

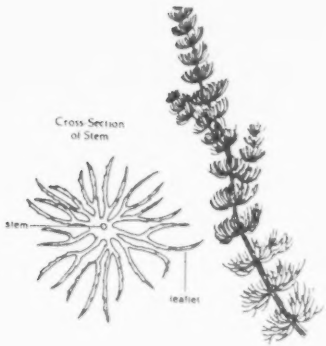


Figure 11: Coontail
(Ceratophyllum demersum)

Coontail is a rootless submergent plant with spike-like leaflets. Each leaf is forked into 2 or 4 toothed divisions. It is so-named because of the densely bushy stem tips.
Stems 30-150 cm (1-5 feet) long.

(Refs. Caldwell 1962, Moss 1959).

Figure 12: Richardson's Pondweed
(Potamogeton richardsonii)

Richardson's pondweed grows in lakes, ponds and slow streams. The leaves (3-12 cm long) have smooth, wavy margins, clasping bases and may appear to be striped. Flowers are borne on thick spikes, which may rise above the water surface.

(Ref. Fassett 1957)

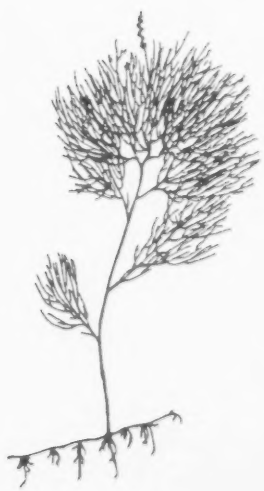


Figure 13: Sago Pondweed
(Potamogeton pectinatus)

Grows in a wide range of aquatic settings including swift water. The finely dissected leaves of this plant are triangular in cross-section and 3-10 cm long. Stems are slender with many branches. Sago pondweed is a rooted plant but the stems often break loose and collect in rows along shorelines.

(Ref. Fassett 1957)

Figure 14: Stoneworts
(Chara sp. and Nitella sp.)

Both types of plants (actually algae) occur submerged in lakes and slow moving streams in which calcium is abundant. Frequently they are encrusted with lime deposits and so feel coarse or gritty to the touch. While they serve to anchor a lake's sediment, they may also impart very obnoxious tastes and odours to the water. Since these plants are really algae, they may not respond to the herbicides normally used to control submergent vegetation. Stems 2-60 cm (1-24 inches) long.

(Ref. Fassett 1957)

Figure 15: Water Milfoil
(*Myriophyllum exalbescens*)

The feather-like leaves of this plant are located in whorls, usually four to a whorl. The flower spikes project above the surface of the water. Milfoil usually is found rooted in dense beds in lakes, ponds and streams. Stems commonly about 1 metre (40 inches) long.

(Refs. Caldwell 1962, Moss 1959)

Figure 16: Eurasian Water Milfoil
(Myriophyllum spicatum L.)

This plant grows primarily on lake bottoms from a fibrous root system similar to the Water Milfoil. During the spring and summer it can grow rapidly from the root area and produce reddish shoots that may reach the surface and flower in water up to 5 meters in depth. This plant is not native to North America but occurs widely in Asia, Africa and Europe. When it was unintentionally introduced to North America is not known, but to date it has become a nuisance in three Canadian provinces and 34 states in the United States. It competes successfully with native aquatic plants and can become a major nuisance to any infected water body. Although there have been no recorded sightings of

Eurasian water Milfoil in Saskatchewan to date, the potential for its spread exists. Boaters can help to prevent its spread by removing aquatic weeds from boat trailers, boats, boat motors, propellers and anchors before launching and after leaving the water. Special care should be taken to remove aquatic weeds from wheel wells of boat trailers, and from the interiors of car-top boats and canoes. Also any suspected sighting of Eurasian Water Milfoil should be reported to the Environmental Protection Branch at (306) 787-1835.

4.1.3 Floating Aquatic Plants and Algae

Floating plants and algae may or may not be anchored. The unattached types are moved around on or just below the water surface by currents or winds.

Algae are tiny plants, most of which are microscopic in size. Algae are very common in Saskatchewan lakes. The presence of algae is necessary for the normal health of a lake. Beneficial roles of algae include its importance as a primary link in the aquatic food chain, nutrient cycling, and oxygen regeneration. However, a few types, particularly certain blue-green algae such as *anabaena* sp. or *microcystis* sp. may become over-abundant in fertile warm lakes and create problems for water users.

Growths of algae dense enough to colour the water are called "blooms". On calm sunny days the bloom-forming algae tend to float at the surface of a lake or slough and form a scum. A light wind or water currents may cause this scum to drift to shore. Heavy winds generally will mix the algae into the water. If the algae bloom is green or light green in color and resembles a wooly blanket it may be a harmless green algae called *cladophora* or *spirogyra*, more commonly referred to as blanket weed.

However, if the bloom is blue-green in colour and has a foamy sheen-like appearance then it probably is a bloom of one of the species of blue-green algae common in Saskatchewan such as *Anabaena sp.* If this is the case it is **important** that water body users contact their local health authority and **warn** people to keep their pets and livestock out of the area and not to drink or come into contact with the infested water. These types of blue-green algae can give off toxins (neurotoxins), which can kill pets and livestock that drink the infested water. These blooms occur naturally during very hot, sunny, dry weather in many of our shallow fertile water bodies in southern Saskatchewan. These blooms are usually very short lived. However, not much can be done when they occur except to avoid the area and wait for them to dissipate.

Other problems excessive algae may cause are:

- taste and odour problems in raw water supplies, clogging filters in water treatment plants and reducing the carrying capacity of water distribution systems;
- foul pump inlets, irrigation siphon tubes and sprinkler heads; and
- fouling shorelines and interfering with recreational uses of water.

Since most algae are microscopic and individuals are not normally seen with the naked eye, none are illustrated here.

Floating vascular plants may be either completely free-floating or they may have floating leaves with stems rooted in the bottom mud. They provide food for many birds, muskrats and moose and shelter and shade for fish.

In excess they may:

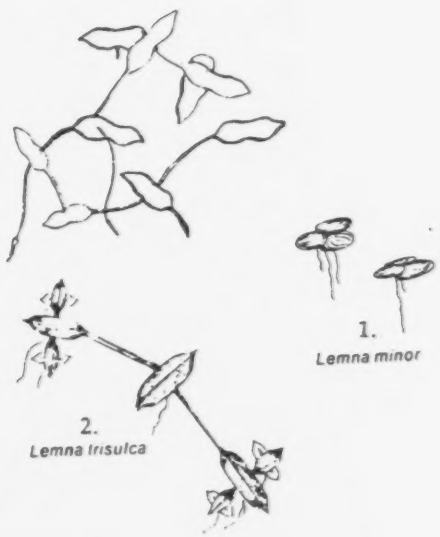
- log siphon tubes, trash racks and pump inlet structures; or
- interfere with recreational uses of water.

The principal floating plants in Saskatchewan are duckweeds and water lilies, shown in the following illustrations.

Figure 17: Duckweeds
(Lemna sp.)

These are very small plants (3-15 mm or 1/8-5/8 inch long). They may form a mat covering the surface of protected shallow bays or ponds. While these mats may resemble scum produced by algae, duckweed mats are not affected by copper sulfate treatments. These plants are **not** toxic and are commonly eaten by waterfowl.

(Refs. Cook 1974, Fassett 1957)



(Nuphar variegatum)

The thick, fleshy leaves of this pond plant arise from a creeping underground stem. The leaves and yellow flowers float on the surface of sheltered waters. Broadly oval leaves are 10-30 cm (4-12 inches) long. Young submersed leaves are often red tinged.

(Ref. Fassett 1957, Moss 1959)

4.2 Control Measures for Nuisance Aquatic Plants

All aquatic plant management control measures in public surface waters in Saskatchewan must receive prior approval from the appropriate regulatory agencies (See Section 5.0).

Over-abundant aquatic plant growth is a symptom of a disorder or imbalance in the aquatic ecosystem. This imbalance is usually a result of an excess of nutrients but may be a lack of competing species or predators and/or some other factor. Aquatic plant problems cannot be solved by a single one-shot treatment of the nuisance plants. Rather, to be effective a control program should not only treat the symptoms (plant growth) but also the causes. A cure is attained when ecological balance is restored and maintained. The term "management" refers to controlling nuisance aquatic species and to restoring or restructuring aquatic plant communities. Producing stable, diverse aquatic plant communities containing a high percentage of desirable species is a primary management goal.

The objective in aquatic plant control should be to maintain the growth of plants in aquatic settings at an acceptable level; a level that is environmentally sound, aesthetically pleasing and one that permits the efficient use of water. The goal is not to eliminate all aquatic plants. This would devastate the aquatic life and ruin long-term water quality as these plants are essential to an aquatic ecosystem's balance.

When aquatic plant growth becomes a problem there are a number of control measures or management techniques that may be tried including: harvesting, water-level fluctuation, sediment alteration, nutrient limitation, light alteration, biological controls and herbicides. Which technique is used depends on the nature and use of the water body as well as its costs and benefits.

It is rare that a single technique is a total remedy in itself. The aquatic plant manager must choose a combination of controls that are the most appropriate to each aquatic weed problem. Control measures merely treat the symptoms and not the causes of the problem and may result in some undesirable secondary consequences. For example, algal blooms may occur due to the release of nutrients from either submerged plants that are killed or from erosion of shoreline material caused from the removal of emergent vegetation etc.

The following is a brief description of each of these techniques.

4.2.1 Harvesting

In harvesting both emergent and submergent aquatic plants are cut, collected and transported to shore for disposal. Technologies such as manually cutting, raking, pulling and dragging aquatic weeds and collecting them on shorelines work well in small areas. Other methods using mechanical weed harvesting equipment, which cut weeds above or below the root systems, have proven effective for large areas. These methods of control are advantageous in that they show immediate results and by removing the plant from the system you remove some of the nutrients and pollutants (metals) in the ecosystem that the plant assimilated during growth. On the downside, this method of control can be labour-intensive and costly. Plant fragments that are not picked up can root and grow a new plant plus disturbing the bottom sediment can release more nutrients into the water column and an algae problem could result. Also cutting and removing aquatic plants affects the food chains and habitat of many aquatic animals such as fish and some wildlife. This method of control requires prior approval from SE (see Table1).

4.2.2 Water Level Fluctuation

Water level fluctuation is a common method used for aquatic plant management. Water levels can either be raised or lowered. Raising the water level can drown out some emergent plants. Lowering water levels or draw down, especially during winter, can expose submersed aquatic plants to desiccation and freezing. Water level fluctuation can be effective on many aquatic plants but not all of them. Also it can hamper the water usage and the habitats and food chains of many aquatic animals. It is limited to water bodies with control structures and a water supply. This method of control requires a drainage approval from Sask Water Corporation and a shoreline alteration permit from SE (see Table 1 – Alteration of Shorelines).

4.2.3 Sediment Alteration

There are two basic ways sediment can be altered to control aquatic plants. Both methods, if carried out in public surface waters in Saskatchewan require prior approval from SE (see Table 1 – Alteration of Shorelines). The first way is by dredging or suction using special mechanical equipment. This method removes the nutrient rich sediment and everything else in it including the aquatic plants. This method is an effective long-term measure; usually limited to small areas. It is generally quite costly and can have a drastic affect on aquatic habitat.

The second method of sediment alteration involves adding clean sediment such as sand or gravel, which is nutrient free and is a poor rooting medium for aquatic plants. This method is effective but again it can be costly. It should be limited to small areas and cannot be repeated indefinitely.

4.2.4 Nutrient Limitation

Nutrient limitation encompasses a number of different methodologies many of which are still being researched. The aim of each is to reduce or limit the amount of nutrients in the water column that are essential for aquatic plants to grow, thereby reducing their populations. Some techniques are quite simple such as aeration (pumping air into the bottom water), keeping the water well oxygenated prevents the release of nutrients into the water column from the sediments, which can occur under anaerobic conditions. Another simple method involves trapping some of the nutrients coming from surface runoff using strategically placed straw bales. These can act as filters on the incoming water by trapping suspended sediment. Some methods involve the addition of various chemicals such as alum, iron or calcium compounds such as lime. These chemicals bind nutrients such as phosphorous in the water.

A healthy riparian or shoreline zone also reduces nutrients in the water column. Plant growth in the riparian zone acts as a filter, slowing the flow of runoff. This gives the nutrient rich runoff time to sink into the soil reducing the nutrients and sediments entering the water body.

Such methods have had limited success with algae but not with macrophytes because the nutrients in the sediment are still available to rooted aquatic plants. A permit is required from SE (Table 1) if any chemical is to be added to surface water unless it is wholly contained on private land (Table 1).

4.2.5 Light Alteration

Sunlight is essential to aquatic plants. Altering the amount of sunlight a plant has available can be used as a control measure in aquatic plant management. There are a number of ways sunlight can be limited:

- increasing water depth by dredging or raising water levels will reduce the amount of light that reaches the bottom;
- increasing the turbidity of the water by (e.g. adding a water-soluble dye). will reduce the light penetration;
- deploying a floating shade or black polyethylene sheet will block light penetration below the surface;
- using a bottom barrier or weed blanket will limit light penetration to the sediments and provide a physical barrier to growth; and
- planting shading vegetation along the banks of the water body can help reduce the amount of light reaching the shallow shore areas that provide prime aquatic plant habitat.

All these methods are effective and may be relatively inexpensive but are limited to small, shallow water bodies or small areas on large water bodies. However, they may have some adverse effects on other aquatic organisms in the area.

4.2.6 Biological Controls

Biological controls are an environmentally friendly control measure. They involve the use of natural organisms to maintain plant pests at tolerable levels. Biological control has become quite extensive and diverse. Examples include grass carp (weed-eating fish), midge larvae, weevils, snails, crayfish, competitor plants, waterfowl, aquatic mammals and microbial parasites and pathogens. Even enhancing the natural decomposing bacteria in aquatic ecosystems have been proposed for plant control.

There are a number of successes with these control measures however others are still being fine tuned for better results. Researchers and managers in this field have a tremendous environmental responsibility, especially when introducing non-native or biologically altered species as control agents. For this reason in Saskatchewan these types of control measures require prior approval from appropriate government agencies and are reviewed on a case-by-case basis.

4.2.7 Restoring Aquatic Plant Communities

A new technique of aquatic plant management is presently emerging and looks promising. This method involves reintroducing native species of plants that are more desirable than the nuisance species. Planting is used to increase population densities and expand the range of the desired species.

4.2.8 Herbicides

Chemical treatment is the most frequently used control method in Saskatchewan. Herbicides are easy to use, effective, usually act rapidly and can be used in a variety of aquatic situations. On the downside, chemical control is rarely target-specific and most of the chemicals are, or can become (through bioaccumulation) toxic to other aquatic organisms and animals. Many aquatic plants are resistant to

certain chemicals and as a result these plants may become a nuisance. Chemical treatment is a short-term solution to a long-term problem and may in fact be more expensive or create a larger problem in the long run. Whenever chemicals are used to control aquatic nuisances great care must be taken to minimize affects on non-target organisms. For these reasons SE suggests that aquatic plant control managers choose this method of control as their last option.

A permit from SE is required if herbicide is to be applied to any surface water in Saskatchewan unless it is wholly contained on private land. As well, chemical applicators may require a pesticide applicators license from Saskatchewan Agriculture, Food and Rural Revitalization (SARR)(see Table 1). In fact, due to the dangers and complexities involved in applying chemicals to control aquatic weeds, it is suggested that all applicators acquire a pesticide applicators license.

4.3 Other Aquatic Nuisances

4.3.1 Biting Flies (Mosquitoes and Black Flies)

Biting flies such as mosquitoes and black flies annoy most people and many animals, especially during the summer. Some of us can avoid most of this nuisance problem, but it is a more insistent concern for vacationers and outdoor workers as well as farmers.

4.3.1.1 Black Flies

Black flies can become a major nuisance to central Saskatchewan livestock and can cause them considerable stress. For this reason, SARR funds a Black Fly Abatement Program. This program is quite costly, intensive and difficult to undertake because black fly habitat exists in large rivers such as the North and South Saskatchewan. To help lessen the effects of black fly attacks, livestock owners should use "on farm" methods such as oil rubbers, electrostatic sprayers etc. to help protect their animals from attacks. Switching to a light color breed of cattle in areas where biting fly outbreaks are common has been known to help lessen the impacts of biting fly attacks. All black fly problems should be referred to this program. For further information on this nuisance and its prevention contact:

The Prince Albert Agricultural Development Board
Black Fly Abatement Control Centre at (306) 763-0609 **(Summer Months Only)**

4.3.1.2 Mosquitoes

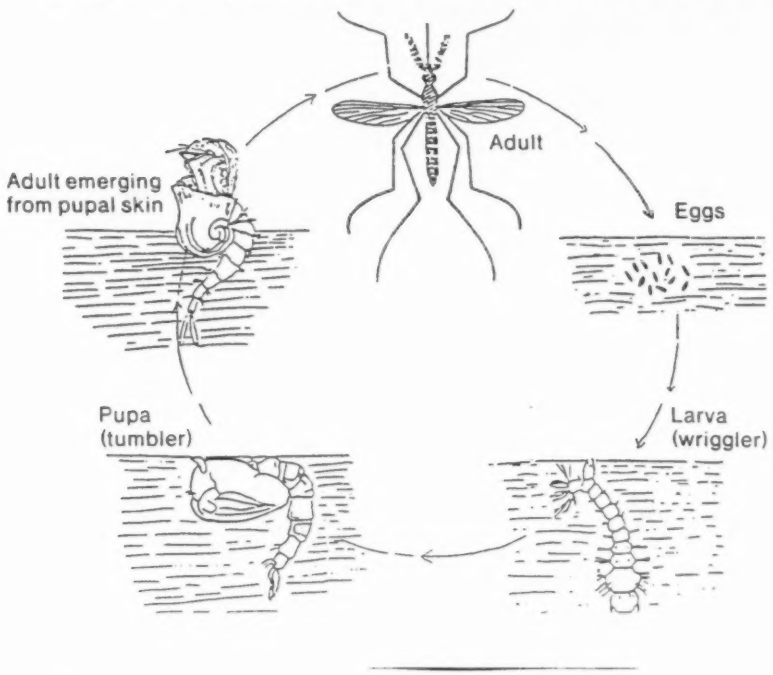
Most mosquitoes are not a threat to health; nevertheless, certain types of mosquitoes can carry viruses capable of producing encephalitis, an infection of the central nervous system.

A mosquito-borne disease of concern in Saskatchewan is Western Equine Encephalitis (WEE). This disease has occurred in modest epidemic form on the prairies affecting many horses and several people on sporadic occasions. Only one or two of the many kinds of mosquitoes in Saskatchewan can carry WEE. A surveillance and control program is in place to ensure that outbreaks of WEE are prevented. For further information on this disease and its prevention, contact Vikram Misra, Department of Veterinary Microbiology, University of Saskatchewan at (306) 966-7218.

West Nile Virus (WNW) is also spread by the bite of an infected mosquito. WNV can infect people, horses, many types of birds and some other animals. Most people who become infected with WNV will have either no symptoms or only mild ones. However, on rare occasions, WNV infection can result in severe and sometimes fatal illnesses. There is no evidence to suggest that WNV can be spread from person to person or from animal to person.

Mosquitoes develop through four stages in their life-cycle: egg, larva, pupa and adult (see Figure 19). Hatching of the egg and development of the larva and pupa can only occur in water. These pre-adult stages of the mosquito obtain oxygen directly from the air . They can inhabit sluggish, poorly aerated waters, such as the edges of swamps, temporary pools of melt water or floodwater, weedy shallows of ponds, and small volumes of water in catch basins in storm sewer systems, at the ends of culverts, garden ponds, and water trapped in discarded tires and un-punctured, unburied containers. These are, in fact, preferred breeding places for most mosquitoes. Mosquitoe development unsuccessful in open, well-aerated bodies of water or in running streams.

The larvae are popularly called "wrigglers", from their characteristic motion as they travel to and from the surface where they breathe through their "tail". After three moults, the mosquito is in the pupa stage. This has a relatively large "head", and breathes at the surface without the "wriggler" motions. Finally, at the end of development, the adult emerges from the split pupal skin.



The details of the mosquito life-cycle vary considerably from species to species. They include: preferred host, preferred breeding habitat (temporary or permanent water bodies), preferred water temperature, emergence time, duration of each life stage and number of generations per season. Consequently, effective control of larvae (larviciding) requires considerable knowledge of the biology of the particular mosquito species.

Figure 19: Mosquito Life Cycle

4.3.1.2.1 Mosquito Control Measures

A) Learning to Live With the Problem

This is the most environmentally friendly measure. This means wearing light coloured clothing, not using perfumes, buying over the counter repellents, avoiding going out during peak periods like the cooler parts of the day and other measures which will lessen your chances of being bitten.

B) Preventing the Mosquito Problem

This pest breeds in small aquatic habitats which are rarely of use to man, ***control by habitat reduction is a viable option*** (providing these modifications are environmentally sound in the affected location):

- puncture, crush, and/or bury "dump" items that can otherwise trap and hold snowmelt and rain water; and
- correct and prevent recurrence of erosion pits at the end of culverts, standing water .trapped in culverts and seepage ponds in irrigated areas.

Another measure may be to stock fish in suitable problem waters. Permission to do this must be obtained through SE's local Conservation Officer.

A combination of breeding area reduction and insecticide treatment usually provides the most economical and efficient control of mosquitoes. The effects of habitat reduction are usually long-term or permanent, while pesticides provide only temporary control.

C) Biological Control

Biological control is an environmentally friendly control measure. Biological pesticides containing *Bacillus Thuringiensis* sp. have been proven to be effective in killing mosquito larvae (see Item D below). Biological pesticides are quite target specific resulting in very little loss of other insects.

D) Chemical Control of Mosquitoes

For active chemical control of mosquito numbers, there are two basic approaches:

- killing adults in the aerial or land environment when they are old enough to bite (adulticiding). This method is **not** very effective. Also, terrestrial or aerial spraying of adult mosquitoes is usually prohibited near aquatic systems; and
- killing larvae in the water before adults emerge (larviciding). The low mobility of larvae (in contrast with the adults) makes selective use of the pesticide quite feasible. The remainder of this section focuses on mosquito larvicide programs.

(i) Planning

A good, cost-effective and environmentally sound larviciding program for mosquito control requires careful planning. Larviciding is sometimes effective on a single parcel of private property. But normally, due to the distances mosquitoes may fly or be carried by breezes, effective control calls for joint action by a number of neighbours or by a municipality. Key factors in planning and implementing a successful program are:

- carry out a mosquito survey in the area where control is desired and for several kilometres adjacent to this area, concentrating on areas up-wind;

- determine and map the mosquito breeding sites, paying special attention to the places flooded for only a few weeks in the spring. Such a map must accompany the application for a permit. This can be a section of a topographical map. A contour map (1:50,000) or a Township Photomap is recommended. These are available from Saskatchewan Geomatics Division, Mapping Branch, Information Services Corporation of Saskatchewan, #10 – 200 Research Drive, REGINA SK S4P 3V7, telephone (306) 787-4880
- work out in advance the routes for control equipment to follow into and through the treatment area;
- if possible, arrange for workers from the area to carryout the observations and treatment because they will be most familiar with the terrain and its problems and are more likely to be available to continue control work in future years;
- collate the information on all the above points before formulating the mosquito control program; and
- update the information on the area each year with an early survey of breeding sites since these depend upon factors that can change from year to year.

(ii) The Survey

Effective control depends upon an accurate biological survey. An accurate survey should:

- start in early spring;;
- locate the actual breeding areas, map the abundance of larvae;
- determine how developed the larvae are; and
- identify and map the wet areas where larvae are present and also where they are absent.

(iii) Treatment Timing

Mosquito larviciding is best carried out when the larvae are about half-way into their development, toward the pupal stage. They should be roughly 5 to 10 millimetres long. These guidelines are adequate for the more conventional larvicidal chemicals. For insecticides that work by altering development, more precise identification of the stage of development is essential. The target is usually a stage near pupation, as indicated on the product label. If the severity of the problem warrants, second generation mosquito larvae may be treated later in the season. In any case, the effectiveness of the program should be determined through regular follow-up surveys. Such surveys may indicate a need for repeat treatment.

a) Method of Application

- treat only the documented breeding areas;
- carefully follow the instructions on the label;
- use only the recommended means of application. Larvicidal formulations may be spray concentrates, granules or capsules and need to be distributed in different ways; and
- treatment by spraying from aircraft requires special planning.

b) Restrictions and Precautions

- wet areas not containing larvae should not be treated with insecticides;
- treatment of wet areas where larvae are not abundant would be inefficient, expensive and may be environmentally damaging;

- many mosquito larvicides work by disabling the insect's nervous system. These chemicals may have similar effects on the nervous systems of other animals, including man. Therefore, precautions on the labels must be rigorously observed; and
- most products are only registered for use in standing waters wholly confined on users property with no outflow to adjacent lands or watercourses.

c) Follow Up

The effectiveness of treatment and the need to repeat larviciding should be assessed through regular follow-up surveys. These surveys should be done:

- 24 hours after the treatment;
- once a week throughout the breeding season; and
- one to two days after heavy rains from midsummer to early fall.

If using insecticides that alter development, larval counts cannot be used as a criterion for treatment effectiveness. In this case, numbers of adult mosquitoes is the criteria. An excellent web site reference is http://www.mosquito.org/mosquito.html which has the most up to date information.

4.3.2 Leeches

Leeches are slow-moving creatures related to the common earthworm. A few species cling to waders and swimmers and suck blood from their skin. The leeches are easy prey to fish and generally become a problem only in areas without resident fish populations. Leeches can sometimes be controlled by stocking fish in the water body. Permission to do this must be obtained through SE's local Conservation Officer.

Another successful method to control leeches is bait trapping. Punch small holes in the sides of a metal can with a re-closable lid such as a coffee can. Bait it with raw meat. Once the leeches have entered and fed, they cannot leave. Remove the can from the water and dispose of, sell, or use the leeches as bait.

Ducks have been used to control leech populations, but an overabundance of ducks can create other problems. For example, ducks can host a number of parasites such as swimmers itch and duck waste is high in phosphorous.

NOTE: There currently are no chemical measures to control leeches that are allowed in fish bearing Saskatchewan waters.

4.3.3 Swimmer's Itch (Schistosomedermatitis)

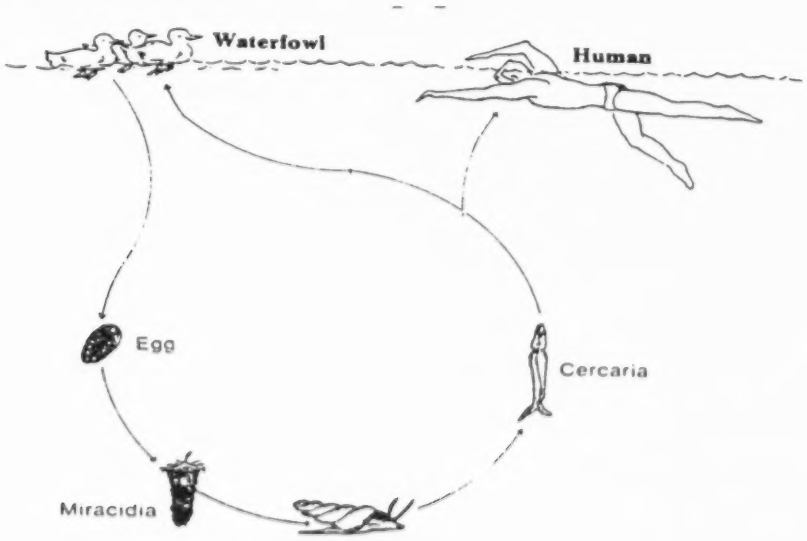
Swimmer's itch is a temporary infection caused by a tiny trematode worm, which spends parts of its life inside certain snails. The parasite emerges from the snail as a larva (cercariae) during warm weather and must find another host (usually waterfowl) within 24 hours (see Figure 20). The cercariae will burrow into the bird's skin and continue to develop into an adult worm (Schistosome).

Swimmer's itch occurs when the cercariae accidentally tries to burrow into human skin. Since man is an unsuitable host, the cercariae are quickly destroyed. This causes an allergic reaction and skin irritation.

The parasites burrow into the swimmer's skin when it begins to dry. Swimmers can therefore control the itch by toweling the body dry or taking a shower in fresh water immediately after leaving the water and/or by applying baby oil or vaseline to themselves before entering the water. This removes or prevents the parasites from entering the skin. The shower must be located at the beach site with a water supply other than the lake. Another method of control is to keep waterfowl away from beach areas by posting fake predatory birds such as eagles or owls around the area. Swimmers itch outbreaks in Saskatchewan are usually very short lived as the parasite only survives for about two weeks under optimum conditions which usually occur in July. Another method of learning to live with the problem is to simply avoid swimming during these peak times. Also, swimmers itch can be very localized where one side of a beach or cove can be infected whereas another side may not be infected. If you detect the itch in one area, try another.

NOTE: There currently are no chemical measures to control swimmer's itch that are allowed in fish bearing Saskatchewan waters.

Figure 20: Life Cycle of Swimmer's Itch



4.3.4 Fish

The control of fish in any surface water in Saskatchewan is regulated through SE's Fish and Wildlife Branch. Permits are necessary to stock, transport or remove fish from surface water in Saskatchewan.

For information on fish control, contact:

Saskatchewan Environment
Fish and Wildlife Branch
Box 3003
Prince Albert, Saskatchewan
S6V 6G1
Phone: (306) 953-2896

OR

3211 Albert Street
Regina, Saskatchewan
S4S 5W6
Phone: (306) 787-2314

4.3.5 Zebra Mussels (Dreissena polymorpha)

Figure 21: Zebra Mussel

Zebra Mussels are small (about the size of your thumbnail) bi-valves (shelled aquatic animals). They are not native to North America and were accidentally introduced into the Great Lakes in ballast water carried by ships from Europe. Since this occurred, the animals have spread rapidly through the Great Lakes and northeastern United States. They have become a nuisance in many of these regions mainly by encrusting the inside bores of pipes and water systems. Water intakes with flow provide ideal habitats for zebra mussels. Their presence jeopardizes the supply of water for domestic, agricultural, industrial purposes and they can have a wide range of ecological impacts. To date, there has been no control measures that have proven effective. So preventing the spread of zebra mussels is of particular concern to all water users.

Zebra mussels have not been found in Saskatchewan but the potential for infestation is very real. To help stop the spread of zebra mussels into Saskatchewan, water users should insure boating equipment is clean of all plants and animals before launching and after removing from water bodies. Special attention should be given to equipment that has been used or purchased from out of the province. We need to cooperate with other jurisdictions to help control the spread of this alien species.

4.3.6 Nuisance Birds and Wildlife

Certain species of birds and wildlife such as cormorants, herons, loons, beavers and muskrats can become a nuisance in certain situations. For example, beavers can obstruct a waterway or drainage ditch by building dams. Certain bird species can affect fish populations. Controlling these kinds of nuisances is allowed under special conditions and requires prior approval from the SE please contact them at:

Box 3003
PRINCE ALBERT SK S6V 6G1
Phone: (306) 953-2896

OR

3211 Albert Street
REGINA SK S4S 5W6
Phone: (306) 787-2314

5. Policies and Regulations

Limited, localized use of chemicals is acceptable for control of aquatic nuisances. Such chemicals must however be used with extreme caution. Label regulations and restrictions created by the Pesticide Management Regulatory Agency of Health Canada must be followed.

Under Section 35(1)(b) of *The Environmental Management and Protection Act (2002)*, a **permit is required if a substance is to be applied to any surface water or along the banks or shore of surface waters in Saskatchewan**. This includes intermittent waterways and drainage ditches, even when dry. The only exceptions are non-draining water bodies, such as dugouts, which are wholly contained on private land. To be exempt, such water bodies must **not** discharge surface water at **any** time to adjacent properties or waterways.

A permit is required for application of chemicals to surface waters and watercourses:

- where "surface water" means water above the surface of the land and being in a river, stream, watercourse, lake, creek, spring, ravine, coulee, canyon, lagoon, swamp, marsh or other body of water; and
- where "watercourse" means a stream, creek, river, gully, valley floor, drainage ditch or any other channel including any artificial channel, in which water flows either permanently or intermittently.

These waterways are defined to include banks and adjacent lands extending a minimum of 25 metres (82 feet) laterally from the high-water level of such permanent or intermittent waterways, whether wet or dry. In the case of aerial spraying, the adjacent band of protected land is 50 metres (164 feet) from the high-water mark.

Certain areas of Saskatchewan are more sensitive to pesticide effects and may require special protection beyond that provided in these guidelines. In such cases, SE will notify the individual applicant of any special restrictions.

Most permits must be renewed **annually**. Application forms are included in Appendix A. Information and extra application forms may be obtained from your local SE EcoRegion office (addresses and phone numbers are in Appendix B).

Although it may not be a requirement, SE suggests that **all** persons who use pesticides to control aquatic nuisances obtain a pesticide applicators license. Licensed applicators are required to take a pesticide applicators course, which provides information on the proper, safe, efficient and responsible use of pesticides.

Table 1 summarizes the regulations and policies that apply to various aspects of aquatic nuisance control.

5.1 For Mosquito Control Programs

Mosquito control programs are usually carried out on a municipal-wide basis. The following are typical conditions that may accompany a permit to apply mosquito control chemicals:

- follow the label guidelines especially those pertaining to the use of the chemical around food crops or populated areas;
- advise any users of the water that is to be treated. The label on the chemical container should provide information on proper use of treated waters. (Further information may be obtained from Pesticide Management Regulatory Agency, Health Canada, Regina (306) 780-7123 or Saskatoon (306) 975-5219);
- the pesticide applicator requires a commercial operator's license. (Further information may be obtained from SARR, Sustainable Production Branch, Regina (306) 787-4662);
- obtain permission from the owners of land on which you wish to treat bodies of water. This includes bodies of water such as sloughs, which are only partially contained on private land. The applicant may be responsible for providing alternate water supplies for these landowners if activities such as cattle-watering must be discontinued due to the chemical treatment;
- post notices on any water bodies on public land advising that the treatment has been made and providing a contact telephone number for information;
- undertake some type of public information program in the local media such as advertising the mosquito control program in the town newspaper. Mention that the public may learn from the local government office which water bodies and sloughs are involved;
- the chemical applicators or operators should be checked for cholinesterase activity (a standard medical test) as some of the chemicals inhibit the activity of this enzyme; and
- if the mosquito control area is upstream from, or adjacent to a water supply that is used for domestic consumption, larviciding should be restricted to areas greater than 25 metres (82 feet) away from the current surface water level. Should the water level rise and encroach on the treatment area, immediately notify both the local Saskatchewan Watershed Authority regional office and SE's local EcoRegion office (in an emergency call the 24 hour number at 1-800-667-7525). In such a case, the water intake should remain closed until the water level recedes or a chemical analysis shows that there are no mosquito control chemicals in the water.

Table 1
Summary of Policies and Regulations

Activity	Permits Required/Policies	Contact
Application of pesticides to surface waters and adjacent lands.	A permit is required from SE for application of pesticides to waterbodies.	SE's Environmental Protection Branch or SE's EcoRegions
Chemical control of aquatic nuisances (eg. Weeds, algae, mosquitoes, leeches)	See Section 6 for additional information on Appendix A for application forms.	Addresses in Appendix B.
Registration of pesticides.	SAFRR and Agri-Food Canada places restrictions on how and where chemicals may be used. Product restrictions are listed on the container label. It is illegal to import or use pesticides (even on your own land) unless the products are registered in Canada for the intended use.	Pesticide Management Regulatory Agency Agriculture 3085 Albert Street REGINA SK S4S 0B1 Phone: (306) 780-7123 **OR** OR 100 3rd Ave. N. SASKATOON SK S7K 6G7 Phone: (306) 975-5219
Alteration of shorelines (including mechanical removal of rooted vegetation), draining wetlands or modifying stream channels)	A Shoreline Alteration Permit and/or a Fish Habitat Alteration Permit may be required for the mechanical (including by hand) removal of rooted aquatic vegetation above and/or below the high water mark or for draining wetlands or modifying stream channels.	Fish and Wildlife Branch Saskatchewan Environment 3211 Albert Street REGINA SK S4S 5W6 Phone: (306) 787-2314 or Your Local Conservation Officer
Fish stocking (eg., to control mosquitoes or leeches)	Approval required for fish stocking	SE, Local Conservation Officer and/or EcoRegion Fisheries Biologist,
Operating as a commercial applicator of pesticides, operating as a vendor of agricultural and restricted pesticides, or operating a business providing a service of pesticide application	Pesticide applicator license, vendor license or service license respectively, required by SFARR.	Sustainable Production Branch SFARR 3085 Albert Street REGINA SK S4S 0B1 Phone: (306)787-4662 Fax: (306) 787-0428
Accidental spills of pesticides	Regulations require prompt reporting and clean-up of spills.	Spill Report Centre 1-800-667-7525 (24-hour toll free)
Draining waterbodies or modifying stream channels (eg. for reduction of mosquito habitat)	Drainage Approval required for drainage works which drain water onto land not owned by the applicant.	Saskatchewan Watershed Authority • contact your nearest regional office.
Transport and/or disposal of pesticides, pesticide containers.	Regulations require proper transport and disposal of pesticides, pesticide waste and containers.	Local RM Office Local SE Office Crop Protection Institute 1-877-874-3444

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Appendix A

Saskatchewan Environment

Application for Permit: Chemical Control of Aquatic Nuisances in and/or Near Surface Water

In accordance with Clause 35(1)(b) of *The Environmental Management and Protection Act, 2002* a permit is required if pesticides are to be applied to any surface watercourse in Saskatchewan. This includes intermittent waterways and drainage ditches, even when dry and areas up to 50 metres from the water's edge. The only exceptions are non-draining water bodes, such as dugouts, which are wholly contained on private land. To be exempt, such water bodies must not discharge surface water at any time to adjacent properties or waterways. I hereby apply for a permit.

Address _____

1. Name of Applicator _____ Applicator's Licence #: _____
   Postal Code: _____ Telephone: _____
2. Chemical to be applied on behalf of _____
   (person or agency)
3. Purpose of treatment:
   [ ] Algae
   [ ] Emergent Plants (e.g. Cattails)
   [ ] Submergent Plants
   [ ] Insects (specify) _____
   [ ] Other (specify) _____
4. Chemical** to be used (product name and product registration #) _____
5. Dosage Rate: _____
6. Size of area to be treated: _____ Average depth: _____
7. Total amount of chemical to be applied: _____
8. Number of times chemical to be applied: _____
9. Method of chemical to be applied by: _____
10. Period of treatment: _____ to _____
11. Name or location and description of water body to be treated (attach a sketch plan): _____
12. List major water users (including fish/wildlife) that may be affected: _____
13. I agree to follow instructions outlined by the manufacturer with specific reference to the rate of application, concentration of the chemical applied and safety factors related to the application.
14. I understand and agree that any permit granted is valid only within the calendar year of issue, unless otherwise stated on the permit and is subject to cancellation at any time at the department's discretion.
15. In consideration of the granting to me of a permit to apply chemicals, I hereby undertake to save harmless and agree to indemnify the Province of Saskatchewan, its officers and employees from and against all damages, losses, costs, charges and expenses which the province, its officers and employees may sustain or incur or be liable for in consequence of such claims or demands, or of its having granted to me a permit to apply chemicals.
16. I certify that the information contained in this application is true, complete and accurate.

Signature of Applicant: _____ Date: _____

Fully complete above and submit to:
Saskatchewan Environment (SE)
Environmental Protection Branch
Room 224, 3211 Albert Street
REGINA SK S4S 5W6

OR Your nearest SE Ecoregion Office

Office Use Only

Permit Granted: _____ 20____. Permit No.: _____

* Please allow approximately 20 working days for processing. ** Only one chemical per permit. This form may be photocopied.

Appendix B

Saskatchewan Environment

EcoRegion Office Contacts

Grassland EcoRegion ..... **(306) 778-8212**
350 Cheadle Street West
SWIFT CURRENT SK S9H 4G3

Parkland EcoRegion ..... **(306) 933-7940**
102-112 Research Drive
SASKATOON SK S7K 2H6

West Boreal EcoRegion ..... **(306) 236-0402**
Unit 1 – 101 Railway Place
MEADOW LAKE SK S9X 1E6

East Boreal EcoRegion ..... **(306) 953-2296**
6TH Floor, PO Box 3003
PRINCE ALBERT SK S6V 6G1

Shield EcoRegion ..... **(306) 425-4249**
Po Box 5000
LA RONGE SK S0J 1L0